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COMPARISON OF ORGANOELEPTIC ACCEPTABILITY OF LIQUID AND FRESH DIETS

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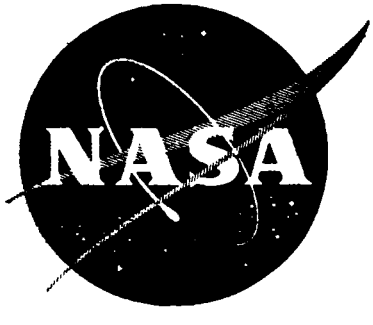

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FOREWORD

This research was initiated by the Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, and was accomplished by the Department of Research of the Miami Valley Hospital, Dayton, Ohio, and the Biotechnology Branch, Life Support Division, Biomedical Laboratory, Aerospace Medical Research Laboratories. This effort was supported jointly by the USAF under Project No. 7164, "Biomedical Criteria for Aerospace Flight," Task No. 716405, "Aerospace Nutrition," and NASA Manned Spacecraft Center, Houston, Texas, under Defense Purchase Request R-85, "The Protein, Water, and Energy Requirements of Man Under Simulated Aerospace Conditions." This contract was initiated by 1st Lt John E. Vanderveen, monitored by 1st Lt Keith J. Smith, and completed by Alton E. Prince, PhD, for the USAF. Technical contract monitor for NASA was Paul A. Lachance, PhD. The research effort of the Department of Research of the Miami Valley Hospital, was accomplished under Contract AF 33 (657)-11716. Bernard J. Katchman, PhD, and George M. Homer, PhD, were technical contract administrators, and Robert E. Zipf, MD, Director of Research, had overall contractual responsibility. This report was presented at the 48th Annual Meeting of the American Dietetic Association held in Cleveland, Ohio, 1-5 November 1965.

The authors wish to acknowledge the assistance of Mr. Virgil Rehg, Research Associate, Ohio State University, for statistical analysis of the data, and SSgt Earl T. Rawls of AMRL for his role in the preparation of the metabolic diets used in this research.

This technical report has been reviewed and is approved.

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ABSTRACT

Data on the organoleptic acceptability of a liquid diet formula with a variety of flavors and two other diets composed of fresh foods was obtained from eight subjects during two, forty-two day experiments. An analysis of the acceptability ratings permits the following conclusions to be made: a) Even when variety is limited, the acceptability of a fresh food diet is considerably higher than the acceptability of a liquid formula when given as the sole source of nutriment. b) The bittersweet chocolate-flavored beverage was preferred over the other flavors. c) Differences inherent among individuals cause statistically significant variation in food acceptability ratings. d) Over an extended period of time, monotony may be overcome by incorporating a liquid formula into a diet composed primarily of solid foods. This approach merits further investigation.

SECTION I

INTRODUCTION

The development of foods suitable for prolonged aerospace missions has been the object of extensive research. Limitations within the space craft itself present many problems; food materials must be reduced to an absolute minimum of space and weight and yet supply optimum nutrition for astronauts. The space nutrition program has provided bite size compressed and dehydrated foods for Project Gemini. The use of these processed foods is not totally without disadvantage; therefore, continued effort is being made to improve them as well as to investigate other possibilities.

Liquid dietary formulations are one type of food currently being studied. Sarett, among others, has reported (1) the practical application and advantages of formula diets for infant and tube feedings, as well as for the treatment of ulcers and obesity. Liquid diets have unique advantages for a space nutrition program. They assure adequate nutrition since they can be adapted to meet individual nutrient requirements and insure water intake. In dry form, the powder is lightweight, easily stored, and can be consumed with minimum preparation in flight. The use of a liquid formula simplifies the experimental determinations of a metabolic balance study because the exact amount of formulation consumed can be readily monitored. Certain liquid diets decrease fecal output and allow limited control of flatus (2). Also, liquid diets may be formulated with different flavors and colors and thereby provide a degree of variety which is desirable.

These advantages prompted the Biospecialties Branch of the Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, to evaluate the organoleptic quality of thirteen commercial and eleven experimental liquid formulations by means of a taste panel consisting of interested staff personnel. The experimental laboratory-developed formulations were generally more acceptable than the available commercial products and one experimental liquid formula was found to be superior to the other products tested (3). This product was used in two, forty-two day studies to determine nutritional balances and digestibility in conjunction with a nutrient-matched fresh diet. These experiments were but two in a series of twelve joint USAF/NASA experiments to study the precise caloric, protein and water requirements of man under controlled environmental conditions and to evaluate personal hygiene procedures designed for long-term flights.

The purpose of this paper is to report the organoleptic acceptability of both the fresh and the liquid diets and to evaluate the effect of selected factors on the acceptability levels obtained.

SECTION II

METHODS

Eight healthy male college students, four for each of two six-week studies, were maintained in a controlled activity facility for one week before and one week after the four-week period spent in the Life Support Systems Evaluator; the evaluator is used to study and to determine the feasibility of techniques and systems having aerospace application.

In experiment A, a one-day cycle control diet composed of fresh, frozen and heat processed foods was designed to match nutritionally the four flavors of the liquid formulation (chocolate, vanilla, cherry, and strawberry). The fresh diet was served during the first twenty-one day period and the liquid dietary formulation was consumed during the last twenty-one days. Each diet was divided into four equal meals which were served at four-hour intervals. Four different types of meat and fruit provided variety in the fresh diet. Each meal consisted of five items: meat (canadian bacon, roast veal, chicken or roast beef), bread and butter, lettuce with oil and vineagar dressing, canned fruit (applesauce, pears, pineapple or peaches), and tea with sugar.

Experiment B was modified to take into account the addition of butterscotch- and raspberry-flavored liquid diets and because the subjects objected to the salad in experiment A. Since flavor was the only variable in the liquid diets, variety in the fresh diet was limited to changes in pudding and beverage flavors. The four items consumed at each meal in this experiment were: canadian bacon and cheese sandwich, sliced peached, artifically-flavored pudding, and fruit-flavored beverage.

Based upon results reported by Smith, et al. (4), the liquid diet meals were designed to provide 2700 calories. The nutrient composition of the diets calculated from Bowes and Church (5) is presented in table I. All food for the fresh diet was purchased at one time, prepared and frozen prior to the experiment. A commercial firm furnished the dry powder for the liquid diets. Each food item was weighed on a balance accurate to 1.0 gm.

The subjects rated each meal according to a nine-point acale. The results of these ratings were analyzed by analysis of variance (6) to determine the effects of diet, flavor, individuals, and time upon acceptability.

TABLE I

CALCULATED DAILY NUTRIENT INTAKE

Experiment and diet	Total calories	Carbo-hydrate g	Protein g	Fat g	Na* mg	Ca* mg	P* mg	K* mg	Fe* mg
Experiment A									
Fresh diet	2720	216	71.6	174	3790	839	999	1190	28.2
Liquid diet	2700	213	71.8	173	3820	2680	2120	3471	16.9
Experiment B									
Fresh diet	2760	220	72.0	176	3460	1670	1381	2310	15.2
Liquid diet	2750	221	72.5	176	3520	1790	1360	2220	11.3

* Vitamin and mineral supplementation included.

SECTION III

RESULTS AND DISCUSSION

The mean rating score of both studies was 6.7 (like slightly) for the fresh diet and 3.2 (dislike moderately) for the liquid diets, respectively. The difference in acceptability between the fresh and liquid diets is highly significant ($P < 0.01$) in both experiments as demonstrated in figure 1. The lower ratings of the liquid diets might be due to bias resulting from the introduction of the liquid diet in the fourth week in each of the experiments rather than to any innate difference in acceptability of the two diets. However, this bias is not the explanation for the lower ratings because the ratings of the fresh diet were significantly higher than initial ratings of the liquid diet which followed.

The effect of time (monotomy) is evidenced (figure 1) by a decrease in the rating scores given to three of the diets. These results are similar to those reported by Siegal (7) who found that a fresh food diet was rated as less acceptable after repeated servings. In our study the linear downward tend in acceptability is shown by the liquid diets and the fresh diet of experiment B in which essentially the same meal was served four times each day. Tiller has also noted (8) that subjects complained about insufficient variety and monotomy when a semi-solid diet was given for a ten-day period. However a subsequent experiment in the current series, not reported here, did not show a significant effect of time on ratings when a one-day cycle menu of a variety of well-liked fresh foods was utilized for forty-two days. Therefore it appears that unfamiliar, less well-liked or repetitive diets are rated lower with respect to time than those which are well-liked, familiar, or varied.

In experiment A there was no significant difference in flavor ratings. In experiment B, however, the results were highly significant and contributed 49 per cent to the total variance. The difference can be observed in figure 2. The chocolate-flavored beverage received a much higher average rating than the other flavors. While the relative ratings of the strawberry, vanilla, and cherry flavors were the same in both experiments, the chocolate formula was modified and the resulting bittersweet flavor served in the second study was a more acceptable product.

Individual differences among the eight subjects show a high degree of significance as indicated in figure 3. Since these individual differences are significant at the one per cent level, similar differences may be expected in other individuals from the same population.

In addition to the objective ratings, the subjects' recorded comments indicated that the liquid diet became increasingly difficult to consume. The basic formula had a rich and somewhat sweet taste which was not objectionable when consumed in limited quantities, but it became extremely monotonous when consumed in large quantities over an extended period of time. Since acceptability has been shown to affect intake (9) there is a possibility that the subjects' intake would have been below the prescribed level had they been allowed to establish their own levels of consumption. Consideration should be given to these parameters in evaluating a liquid formula for sustenance in space flight.

Liquid diets have been studied by other investigators, however, the experiments have been for shorter durations than those reported here. Finkelstein and McGhee (10) found that a liquid diet could be used as the sole source of nourishment, without adverse physiological or psychological effects, for five days. Our data indicate that the liquid diet may be used for at least twenty-one days. Consolazio (11) found a high caloric, high protein beverage powder to be highly acceptable, but its use was confined to that of a food supplement. Also, studies, related to food designed for feeding pilots on long-range jet fighter missions, have been reported where liquids were considered feasible and

practical when supplemented with solid food (12). Though these studies are interrelated with the material we have presented, quantitative comparison is difficult due to the many inherent differences.

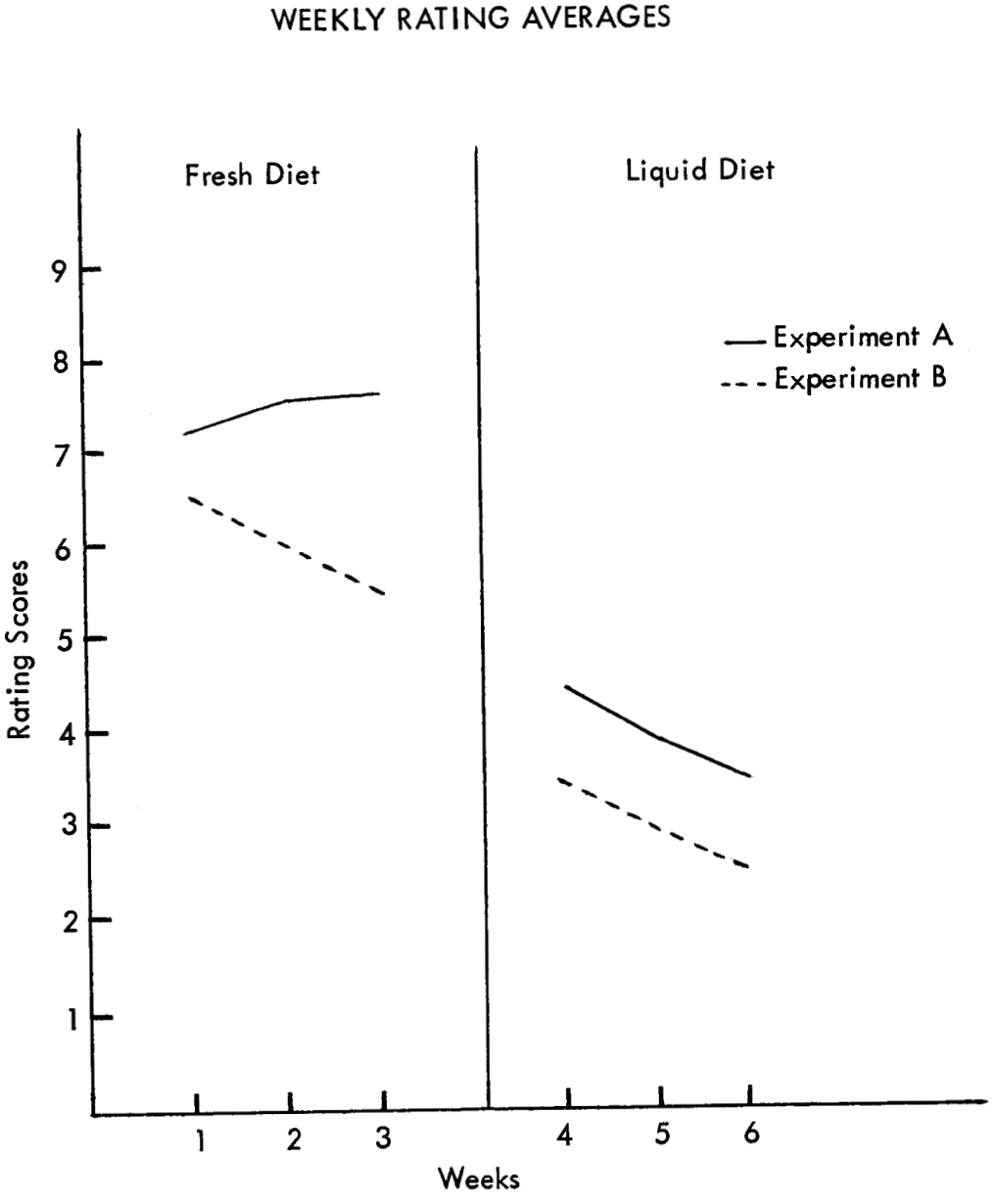

Figure 1. Weekly rating averages.

LIQUID FLAVORS: AVERAGE RATING

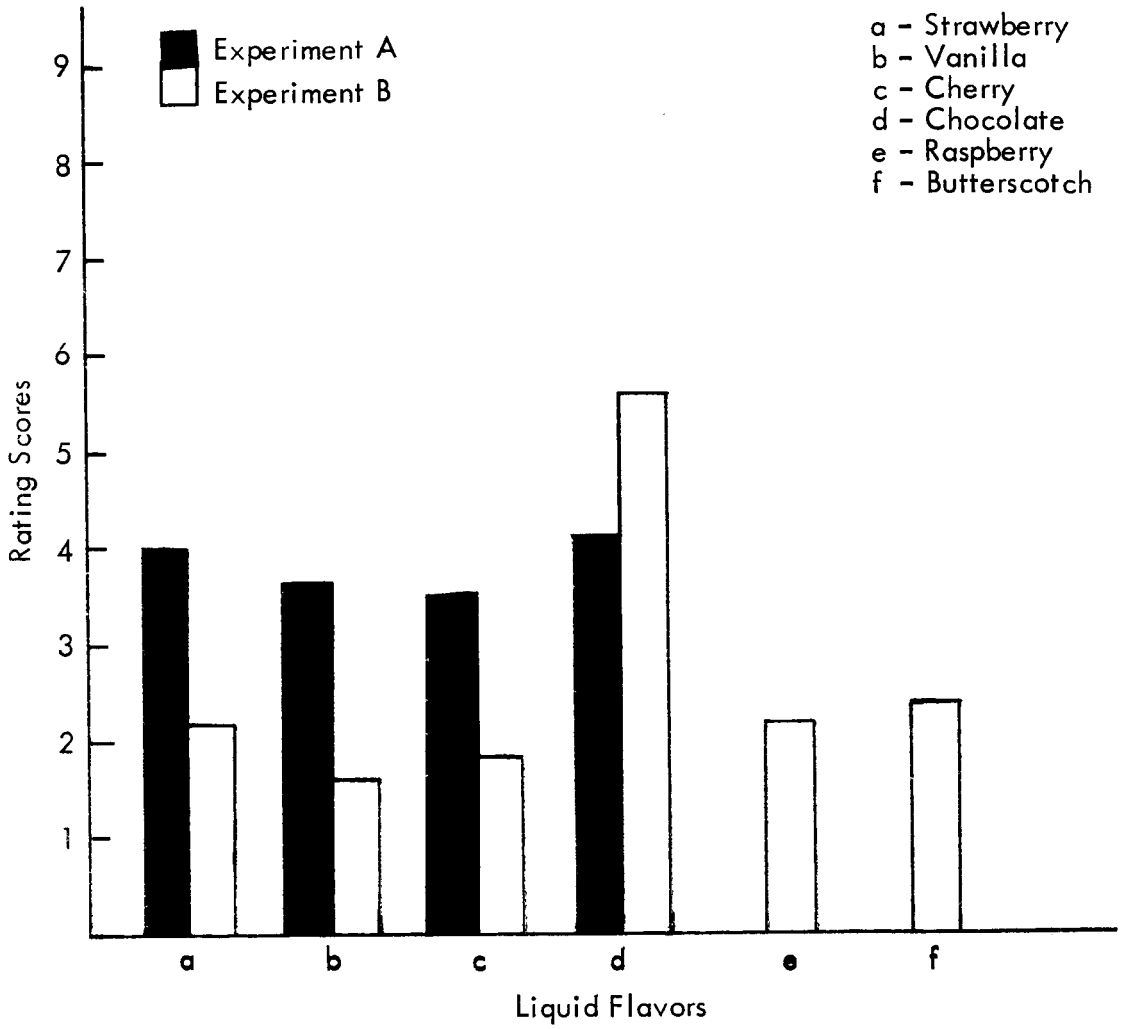

Figure 2. Liquid flavors: average ratings.

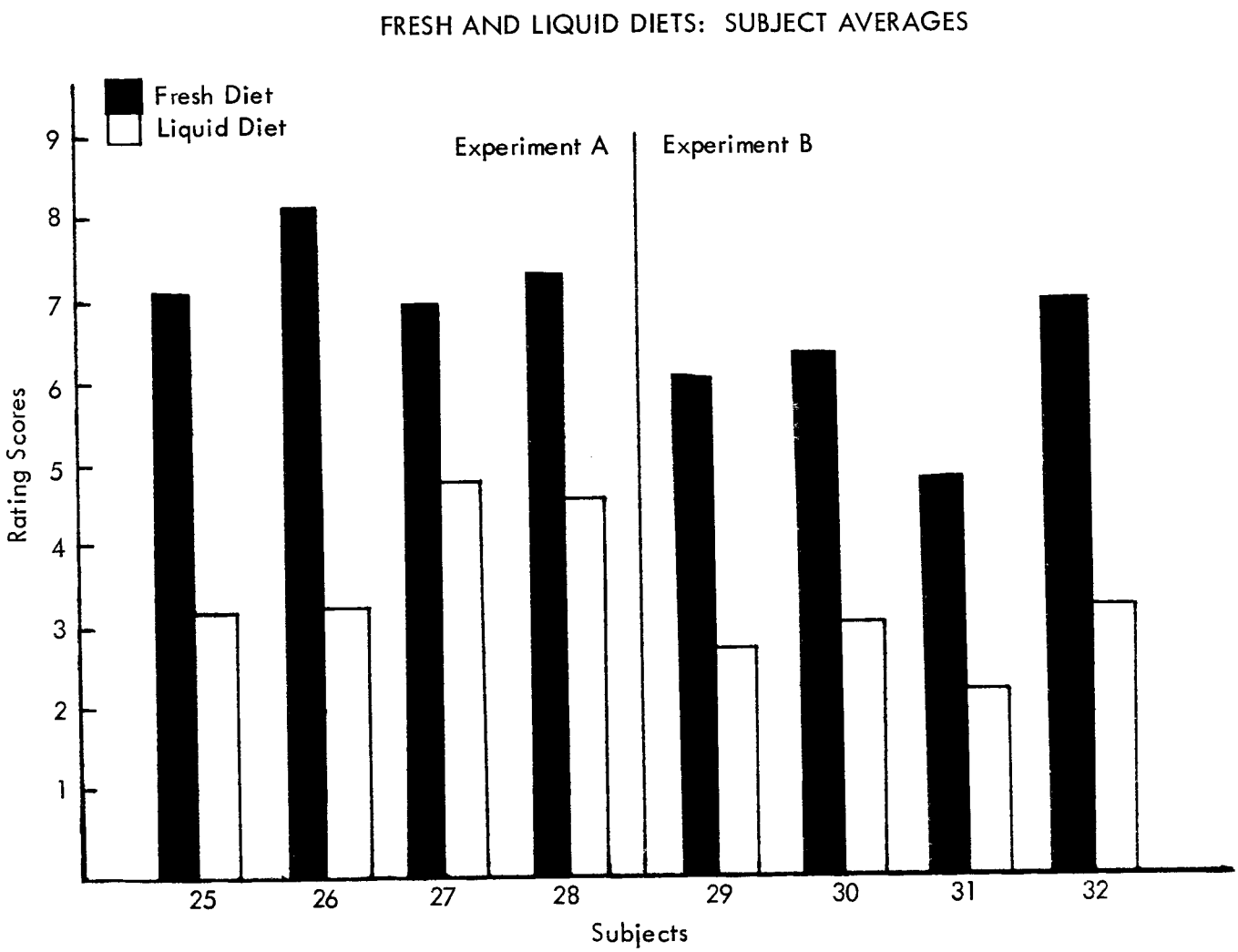

Figure 3. Fresh and liquid diets: subject averages.

REFERENCES

1. Sarett, H. P.: "Use of formula diets." In conference on nutrition in space and related waste problems, University of South Florida, Tampa, Florida, NASA-SP-70. Published by Scientific Technical Information Division, NASA, Washington, D. C., April 27-30, 1964, p 353.

2. Ahrens, E. H., Blankenhorn, D. H., and Dole, V. P.: "The use of orally fed liquid formulas in metabolic studies." Am. J. Clin. Nutr., 3: 336, 1954.

3. Speckmann, E. W., Smith, K. J., and Dunco, D. W.: The nutritional evaluation of commercial and experimental liquid diet formulations for aerospace travel. AMRL-TR-65-155, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, December 1965.

4. Smith, K. J., Speckmann, E. W., Lachance, P. A., and Dunco, D. W.: "Nutritional evaluation of a precooked dehydrated diet for possible use in aerospace systems." Food Technology, 20: (10), 101, 1966, and AMRL-TR-65-98, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio.

5. Bowes, A. P., and Church, C. F.: Food Values of Portions Commonly Used. 9th Edition, Revised by C. F. Church and H. N. Church. Philadelphia: J. B. Lippincott Co., 1963.

6. Hicks, C. R.: Fundamental Concepts in the Design of Experiments. New York: Holt, Rinehart and Winston Publishers, 1965

7. Siegel, P. S., and Pilgrim, F. J.: "The effect of monotony on the acceptance of food." Amer. J. Psychol., 71: 756, 1958.

8. Tiller, P. R., Burns, N. M., and Hanns, T. D.: Environmental requirements of sealed cabins for space and orbital flights. Utilization of semi-solid food diets for extended aerospace missions. NAMC-ACEL-465, U. S. Naval Air Materiel Center, Philadelphia, 1962.

9. Schutz, H. G., and Pilgrim, F. J.: "A field study of food monotony." Psychol. Rep., 4: 559, 1958.

10. Finkelstein, B., and McGhee, B.: Liquid diets for use in high-altitude high-performance vehicles. WADC-TR-59-32, Wright-Air Development Center, Wright-Patterson Air Force Base, Ohio, 1959.

11. Consolazio, C. F., Torres, J. B., and McDowell, M. E.: The acceptability of a high protein, high calorie chocolate drink. Annual progress report on Project No. 6X60-01-001, U. S. Medical Research and Nutrition Laboratory, Denver, Colorado, 1 July 1960 to 30 June 1961, p 79.

12. Mock, R. O.: Feeding on a long-range fighter mission (Operation Fox Paw). WADC-TR-56-5, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1956.

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